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WHY INDUSTRY NEEDS THE JUNIOR COLLEGE.
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IN AN ERA OF RAPID INCREASES IN THE RATE OF TECHNOLOGICAL ADVANCEMENT, THE ECONOMIC SURVIVAL OF INDUSTRIAL FIRMS DEPENDS UPON THE KNOWLEDGE AND SKILLS OF THEIR EMPLOYEES. NORTH AMERICAN ROCKWELL'S SPACE DIVISION HAS DEVELOPED A PROGRAM AROUND JUNIOR COLLEGE TRAINING. PROGRAM GOALS ARE IMPROVEMENT OF EDUCATIONAL STANDARDS, ENRICHING THE JUNIOR COLLEGE CURRICULUM, PROVIDING EMPLOYABLE PEOPLE FOR AVAILABLE JOBS, AND ENHANCING WORKMANSHIP OF THE FIRM. FIVE FACTORS CONTRIBUTE TO THE PROGRAM'S SUCCESS--(1) THE LOCAL COLLEGES AND INDUSTRY ARE MUTUALLY RESPONSIVE TO EACH OTHER'S NEEDS, (2) TECHNICAL SPECIALISTS SERVE AS JUNIOR COLLEGE INSTRUCTORS, (3) INDUSTRIAL TECHNICAL TRAINING AIDS SUPPLEMENT COLLEGE TEACHING, (4) JUNIOR COLLEGES HAVE OUTSTANDING RESOURCES FOR TRAINING TECHNICIANS, AND (5) A CLOSE PERSONAL RELATIONSHIP HAS DEVELOPED BETWEEN COLLEGE AND INDUSTRY PERSONNEL. COOPERATIVE PLANNING OF COURSES AND PROGRAMS RESULTS FROM DAY-TO-DAY COMMUNICATION. TWO COMMON PROBLEMS ARE OVERCOMING INERTIA AND EDUCATING LESS GIFTED STUDENTS. EXAMPLES OF PROGRAMS AND PROCESSES OF ESTABLISHING THEM ARE INCLUDED. THIS PAPER WAS PRESENTED AT THE ANNUAL MEETING OF THE PACIFIC-SOUTHWEST SECTION OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION (33RD, CHANDLER, ARIZONA, DECEMBER 28-30, 1967). (WO)

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CLEARINGHOUSE FOR
JUNIOR COLLEGE
INFORMATION

For Your Information...
...A Technical Paper From The Space Division:

WHY INDUSTRY NEEDS THE JUNIOR COLLEGE

SPACE DIVISION OF NORTH AMERICAN ROCKWELL CORPORATION

JC 680 105

Leland P. Baldwin, Chief
Bureau of Junior College
Vocation-Technical Education
Department of Education
State of California

Personnel from both the Space Division North American Rockwell Corporation and Compton College are to be congratulated on their excellent cooperative efforts. By working together, viable educational programs can be designed and implemented for today's changing and emerging jobs. Lead time is frequently limited. Without a working partnership between industry and education both will suffer. The example in this article of the partnership serves as a fine illustration of how teamwork benefits students, the college, and the community.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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WHY INDUSTRY NEEDS THE JUNIOR COLLEGE

By

Paul B. Ryan
Manpower Development
Space Division
North American Rockwell Corporation
Downey, California

Presented at the 33rd Annual Meeting of the Pacific-Southwest Section
AMERICAN SOCIETY FOR ENGINEERING EDUCATION
December 28, 29, and 30, 1967
Chandler, Arizona

JC 680 105

Most of us today will agree that one of our most important sources of national wealth is educated and trained manpower. Indeed, it is indispensable to our continued national growth, and it may be our nation's ultimate limiting resource.

The premium being placed on education and training throughout all sectors of our society demands special effort by industry and the educational community. And this effort must be concerted. Technology is moving so fast that traditional training, traditional methods, and traditional relationships cannot keep pace. No one has been in a better position in the last several years to recognize this than my firm—the Space Division of North American Rockwell Corporation. We have learned that education and the aerospace industry must move toward their common goals together—or neither may be able to keep up.

Aerospace management, along with the rest of society, faces a critical problem: how to keep abreast of the technology explosion. For all its benefits, this explosion threatens to outstrip our ability to produce enough technicians to keep it going. Compounding the problem is the absolute necessity for excellence in the design and production of both software and hardware.

A profile of man's progress illustrates the telescoping nature of this explosion—which we might call his technological learning curve (Figure 1). In the areas of transportation, electronics, and nuclear science, for example, we have made fantastic advances in the last 50 years. Up to 150 years ago, there had been little or no progress in these areas. Remarkable indeed are the milestones represented in electronics by microwave technology, transistors, and microcircuitry; in transportation by jet engines and rockets; and in nuclear science by terrestrial, space, and marine power plants.

With this historical perspective, we cannot escape the conclusion that the rate at which technology is advancing is not likely to decrease. On the contrary, it will probably increase, testing even further our ability to educate and train the necessary manpower. It is imperative, therefore, that even closer ties be established and maintained between the educational community and industry.

Industry is investing billions of dollars in technological devices and equipment required to produce complex aerospace products. And unless we can also produce technically trained people to use and operate that equipment, it will be useless. There is an even more important economic reason for this technical training: Industrial firms need high-quality employees to remain competitive—for the knowledge and skills of our employees determine in large measure what we produce and how efficiently we produce and market it. So, upon the knowledge and skills of our employees depends our economic survival.

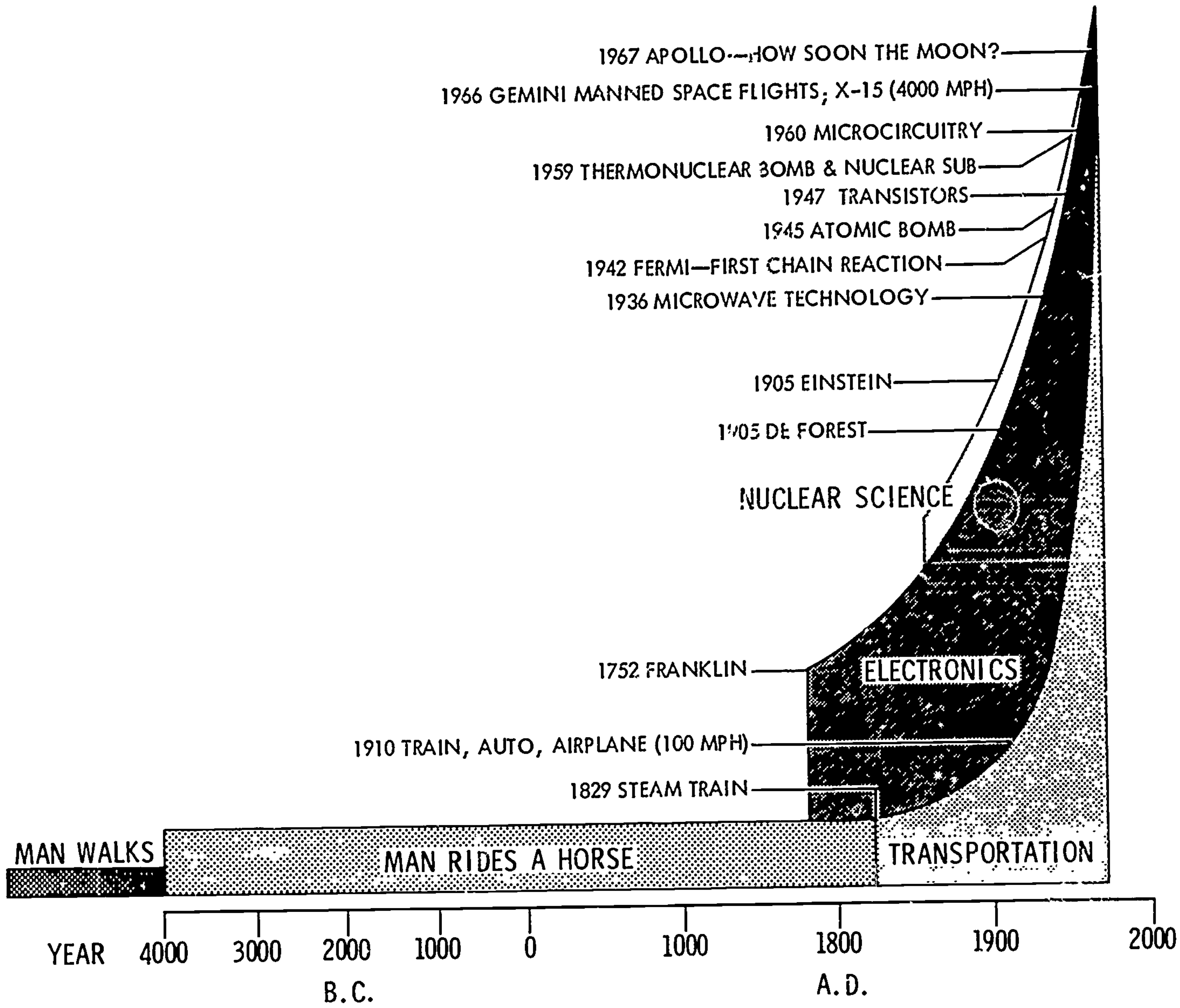

Figure 1. Man's Technological Learning Curve

The impact of this rapid technological development on the social, economic, and educational sectors of our life has impelled industry to seek a closer partnership with the educational community. There is a growing readiness within industry to participate in raising the standards of our educational system. I can tell you that there is certainly a willingness to do so at the Space Division. We have established an entire program around junior college training. We believe that this program to help train junior college students for jobs which are readily available is securing four primary benefits for education and us:

- Helping to improve educational standards
- Enriching the curriculum of the junior college

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- Providing employable people for available jobs

- Enhancing the quality of Space Division workmanship

At the Space Division, we have 23,000 employees, of whom 8000 are listed in 150 technical job descriptions. Many of these employees are involved in computer technology, automatic checkout procedure, design of hardware, manufacture and production, electronic systems, quality control and test, drafting, and facilities engineering. To educate or upgrade employees in these critical areas, we look for—and invariably receive—support from junior colleges.

I should emphasize that we usually prefer to focus our collaboration on individual local colleges—rather than on regional or national associations. This is not difficult to do, because within a 30-mile radius of our Downey headquarters are 34 institutions of higher learning, many of which are junior colleges (Figure 2).

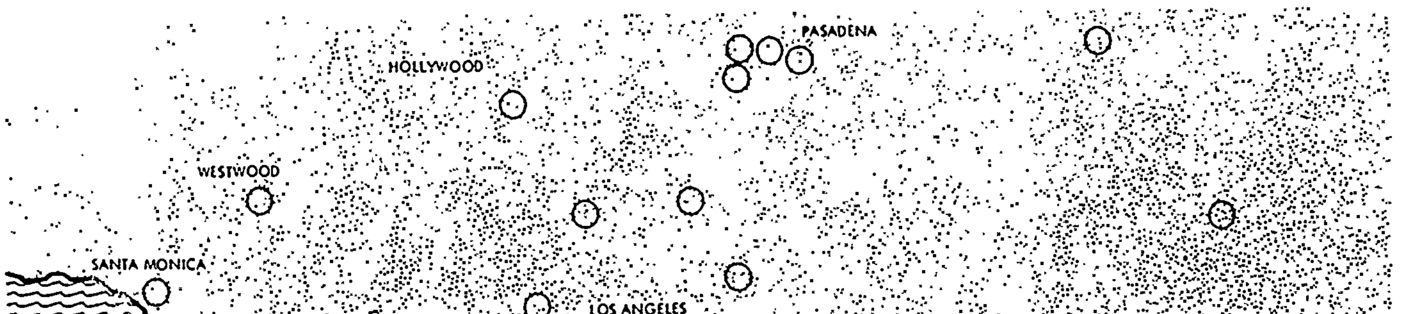


Figure 2. Colleges Located Near Space Division

Working closely with the local educational community during the last four years, we have established 33 courses in computer technology, electronics engineering, mathematics, and other subjects at six junior colleges. In one year, 500 Division employees amassed 10,000 student hours at junior colleges, all on noncompany time and all in job-related courses.

How was this accomplished? First, we in industry share with the junior colleges an awareness that the quantum jump in technology has changed the methods of educating technicians and of shaping college technical courses. If the junior college community has been alert to the changing needs of industry, our Space Division staff has been equally responsive in helping the junior colleges to meet their requirements.

Second, we have a large number of technical specialists who can and do serve as instructors in junior colleges.

Third, we have various technical training aids which can be used to supplement the teaching methods in junior colleges.

Fourth, junior colleges in the Los Angeles area have outstanding physical and intellectual resources for producing trained technicians for industry.

Fifth, we have developed a strong tie between individual college instructors and our own educational staff members.

Both we and the junior colleges have recognized our common problems—and our common mission. This mission is to collaborate in establishing a continuing program of vocational and technical courses in applied sciences and engineering technology in order to

- Improve the standards of the educational system
- Qualify students for employment in jobs available in the community

Note the emphasis on the word available. Too frequently, students attend junior college with no plans for preparing themselves for employment. We design our courses for existing jobs. If a student completes our program, he is assured of being prepared for employment—for usually the job antedates the course. This, we feel, is a revolutionary approach to college teaching. It not only assures us of trained manpower but reduces the unemployment rate in the community.

Day-to-day communication is the key to our junior college educational program. Working on a personal basis, our staff and the junior college faculty members have succeeded in overcoming administrative drag and red tape. Specifically, they

- Identify educational requirements common to our industry and the college

- Set up college courses which not only satisfy college requirements but are geared to long-range opportunities at the Space Division

- Formulate performance objectives which are linked to on-the-job performance

- Determine present student competence by college-administered tests

- Jointly select course content

We call this joint effort Stage 1. After these determinations have been made, we are almost ready to teach the student. But first, to ensure that the course content is compatible with our industry's needs, we proceed to Stage 2 of the plan.

Our Division instructors pretest the course by teaching it to our employees in in-plant courses. After any adjustment, jointly agreed to by the college faculty and our staff, the instructors select instructional material—some from the Space Division and some from the college. If required, the Space Division provides pre-enrolled students for the course to be taught at the college. Upon request, the Division also makes available competent, credentialed instructors—who may be engineers, mathematicians, or technicians—to teach the courses. These instructors teach on their own time and receive compensation from the college. Moreover, to update the regular junior college faculty in the latest technical advances, we invite them to attend in-house Division courses and to teach these courses to our employees at the Space Division.

Once the courses are established, we jointly provide the necessary follow-up to ensure a minimum time lag in advancing the student from the classroom to industry. The action steps in this follow-up are as follows:

- We jointly evaluate the individual courses which our staff and the college have developed and make appropriate changes.

- Before a course has been accepted into the curriculum, the college seeks accreditation from the California State Department of Education.

- As courses in the same field are developed and tested, we jointly offer basic core courses which permit the student to advance to computing, electronics, or other technical areas.

- Concurrently, we may program a series of allied courses in a certificate program. Such a certificate is recognized by our Employment Department as valid evidence of qualification for a position in industry.

- Proceeding further, we jointly adopt courses leading to an Associate in Science degree.

There are three additional action steps which deserve comment:

- For the student who has previously taken in-house industry courses, the college arranges for him to receive credit through qualifying exams.

- For the student who qualifies, the junior college arranges with a four-year college for his transfer to a B. S. program.

- Finally, we promote cooperation between placement officers in industry and the colleges in order to move the students into available jobs.

I'd like to turn now from an overview of our junior college training program to specific innovations. In this respect, I believe that our Associate in Science Degree Program is of particular interest, because it meets an important need in industry. Weighted 60 percent in theory, 40 percent in application, the curriculum includes circuit analysis, applied physics, electronic measurement and statistics, electronic devices and circuits, and control systems. All math study is correlated with lectures, lab work, and other courses. Moreover, the successful graduate may transfer to an engineering course at a four-year college.

This two-year program, which evolved from discussions with the College Electronic Faculty Association, is being introduced at junior colleges in Southern California and Arizona. It originated from core courses taught at the Space Division and was first introduced at Compton College.

The response of employees enrolled in this program has been very encouraging. The course not only offers substantial educational benefits to

the student but helps us to meet our pressing requirements for engineering associates, lab technicians, and inspectors of electronic systems—for all of which positions the graduates will qualify.

Another example of our successful collaboration with junior colleges is the Certificate Program in digital computer design techniques. This program, which is taught at Compton College, evolved from Space Division in-house courses. Compton College instructors, working with our Manpower Development staff, developed the following sequential core of six courses: digital computer concepts, transistor and computer circuits, digital computer design techniques, digital math, basic transistors, and transistor circuit analysis. It is a 27-unit program, and a student may enter at any level by passing a qualifying exam. All courses are 54 hours in length and carry three units of credit. Most of the courses are taught by Space Division employees, who also teach on the college faculty.

These courses have doubled student enrollment in this area at the college. Graduates are in extremely high demand not only at the Space Division but in general industry. Equally important, the program has been approved by the California State Bureau of Vocational Technical Education.

These then are some of the accomplishments of our joint efforts with the junior colleges; I would like now to identify one or two of our common problems. One, which we have not yet surmounted, is how to educate less-gifted students. The burgeoning technology demands that we find ways to teach people with little education or with less-developed learning behavior. Although the answer has eluded us, the aim, as we see it, is to identify what should be taught, how it should be taught, and to whom it should be taught.

We must rely on the educational community to find answers to these questions. One approach may be to couple personal tutoring with the use of computer-assisted or programmed instruction, kinescope lectures, simulators, closed-circuit TV, and telelectures.

A second problem facing education and industry is inertia. Indeed, we have found that resistance to change is one of the largest impediments to progress. I can't speak for education, but industry has many examples of inertia. We need only look at the sad state of the U.S. Merchant Marine and the U.S. shipbuilding industry to realize how inflexible old ways of doing things, plus vested interests, can seriously hurt a once-flourishing industry. The lesson for us would seem to be that resistance to change probably exists in all sectors of society— including education. However, neither we nor education can afford to let sensitivity to criticism and predilection for past procedures prevent us from adopting new ideas and eliminating outmoded ways. It seems clear, as I indicated before, that in this fast-moving technical world of ours industry and education must seek these new ideas and change these obsolete ways—together.

What can industry do to foster this collaboration? First, we must recognize that the junior colleges are indispensable to the needs of industry. Next, we must invite their support in maintaining a capable work force. And finally, after inviting this support, we must encourage it by exerting greater effort to

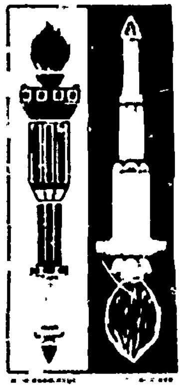
- Identify employment opportunities
- Provide pretested courses, materials, and instructors
- Pre-enroll company employees in college courses
- Conduct in-plant seminars for faculty members to strengthen their technological background
- Help the working student to correlate his academic advancement with his job progress
- Supply technical input to college courses

Having spoken for industry, I'd like to propose that junior colleges consider the following steps, which have been successful in our experience at the Space Division:

- Correlate the curriculum with available employment opportunities
- Integrate pretested industry courses into curriculum and eventually into certificate or Associate in Science degree program
- Encourage faculty members to accept opportunities in industry, including summer employment

And, parenthetically, would it not be feasible for four-year colleges and universities to work up formal courses which the junior college or high school instructor could teach in conjunction with his summer employment? Advanced credit courses for instructors offer an incentive unmatched by summer employment alone. Such courses, combining work and study, would meet in the most effective way the needs of the individual teacher—as well as the requirements of industry and education. Two other inducements the colleges might offer are (1) accredit by exam courses given in plant if they meet academic standards and are related to college work, and (2) schedule classes in day and evening sessions oriented to the working student.

The collaboration of industry and education is becoming increasingly important in our technology-oriented society. Without the junior colleges, industry in general and the aerospace industry in particular would be hard-pressed to obtain the skills required to turn out the complicated products today's technology demands. For its part, industry is making reciprocal contributions by helping the colleges to train employees for better jobs, and students for existing jobs. How well we build this link with the junior colleges will determine in large measure the long-run welfare of industry, the colleges, and the community.



SPACE TECHNOLOGY CERTIFICATE PROGRAM

AT COMPTON COLLEGE

SCIENTIFIC DIGITAL COMPUTER DESIGN - PROGRAMMING
CERTIFICATE PROGRAM

REQUIRED COURSES

1st SEMESTER

2401 BURLING
DIGITAL COMPUTER CONCEPTS
(See Note #3)
54 Hours
3 Hours per week #151
3 Units
7-10 P.M. MON. RM. F19

2404 CORNELL
DIGITAL MATHEMATICS
54 Hours
3 Hours per week
7-10 P.M. THURS. RM. E32

HARDWARE OPTION

2nd SEMESTER

2397 BURLING
TRANSISTOR AND COMPUTER CIRCUITS
54 Hours #82
3 Hours per week 3 Units
7-10 P.M. WED. RM. M4

2403 SZABO
BASIC TRANSISTORS
54 Hours #153
3 Hours per week 3 Units
7-10 P.M. THURS. RM. G-22

3rd SEMESTER

2398 BURLING
DIGITAL COMPUTER DESIGN TECHNIQUES
54 Hours #85
3 Hours per week 3 Units
7-10 P.M. TUES. RM. F21

2394 D'BRAUNSTEIN
ELECTRONIC CIRCUIT ANALYSIS
54 Hours #76
3 Hours per week 3 Units
7-10 P.M. M-W RM. MI, 2

SOFTWARE OPTION (AVAILABLE FALL SEMESTER)

2nd SEMESTER

FUNDAMENTALS OF SCIENTIFIC PROGRAMMING
54 Hours
3 Hours per week

3rd SEMESTER

SCIENTIFIC PROGRAMMING SYSTEMS
54 Hours
3 Hours per week

4th SEMESTER

COMPUTER SOFTWARE
54 Hours
3 Hours per week

NOTES:

1. Entry into any level by qualification survey.
2. Certificate issued by Compton College on completion of "Digital Computer Concepts", "Digital Mathematics" and either "Hardware Option" or Software Option".
3. Approved Alternate for "Introduction To Data Processing" #50

MANPOWER DEVELOPMENT
ARTHUR S. D'BRAUNSTEIN, DOWNEY, X1165

COMPTON COLLEGE
ROGER BEAM, NE-58081

COURSES LISTED UNDER
EVENING ELECTRONICS

DIGITAL COMPUTER CONCEPTS COURSE OUTLINE

1. Introduction and Background
2. Data Processing Fundamentals
3. Types of Digital Computers
4. Applications of Digital Computers
5. Digital Computer Terminology
6. Data Format
7. Types of Storage Devices
8. Computer Theory and Operation
9. Types of Input/Output Devices
10. Stored Program Concepts
11. Machine Programming Systems
12. Complier Programming Systems
13. Program Checkout, Procedure Control, and Programming for Automated Checkout

DIGITAL MATHEMATICS COURSE OUTLINE

1. Numbering Systems
2. Number System Conversion Techniques
3. Binary Arithmetic and Conversions
4. Complementary Arithmetic
5. Binary Coded Systems
6. Octal Arithmetic and Conversions
7. Hexidecimal Arithmetic and Conversions
8. Boolean Algebra Concepts
9. Boolean Algebra Postulates
10. Boolean Algebra Theorems
11. Veitch Diagrams
12. Truth Tables
13. Comprehensive Review

TRANSISTOR AND COMPUTER CIRCUITS COURSE OUTLINE

1. Transistor Gate Logic
2. Multivibrators
3. Schmitt Triggers and Blocking Oscillators
4. Timing Oscillators
5. Special-Purpose Amplifiers
6. Gerromagnetic Cores
7. Binary Counters, Decoders, and Registers
8. Diode and Transistor Matrices
9. Adders and Subtractors
10. Computer Control and Data Flow
11. Arithmetic Unit
12. Computer Memory Systems
13. Input-Output Devices

BASIC TRANSISTORS COURSE OUTLINE

1. Semiconductor Fundamentals
2. Transistor Fundamentals
3. Curves
4. Parameter Calculations
5. Bias Stabilization
6. Using Characteristics, Curves and Charts
7. Audio Amplifiers I
8. Audio Amplifiers II
9. Tuned Amplifiers
10. Wideband Amplifiers
11. Oscillators
12. Transistor Construction Methods
13. Reading Transistor Specifications
14. Transistor Measurements
15. Comprehensive Review

FUNDAMENTALS OF SCIENTIFIC PROGRAMMING COURSE OUTLINE

1. Introduction to Programming
2. Computer Organization and Control
3. Graphs
4. Flow Charts
5. Addressing Systems
6. Simple Routines and Sub-Routines
7. Loops
8. Multidimensional Arrays
9. Data; Field Oriented Machines
10. Lists, Tables, Files, Records
11. Order Lists

SCIENTIFIC PROGRAMMING SYSTEMS COURSE OUTLINE

1. Input and Output Programming Principles
2. Buffering
3. Software Introduction
4. Software Routines
5. Assembly
6. Artificial Programming Languages
7. FORTRAN
8. COBOL
9. PL-I
10. Hybrid Language Systems - ATOLL

DIGITAL COMPUTER DESIGN TECHNIQUES COURSE OUTLINE

1. Systems Summary and Operations of a Digital Computer
2. Digital Computer Design Criteria
3. Natural Data Units and Number Base Configuration
4. Character Set
5. Variable-Field-Length Operation
6. Floating-Point Operation
7. Instruction Formats
8. Instruction Sequencing
9. Indexing
10. Input-Output Control
11. Multiprogramming
12. Central Processing Unit (CPU)
13. Read-Write Control Functions

TRANSISTOR CIRCUIT ANALYSIS COURSE OUTLINE

1. Semiconductor Physics
2. Analysis of the Transistor Circuit
3. Biasing and Stabilization
4. Small-Signal Equivalent Circuits and Analysis
5. Frequency Response Considerations
6. Power Amplifiers
7. Feedback Principles and Applications
8. Power Supply Regulators
9. Integrated Computer Design Techniques

COMPUTER SOFTWARE COURSE OUTLINE

1. Macrocommands
2. Assembler Sub-Routines
3. Assembler Refinement
4. IOCS - Preprocessor, Buffer Subsystem
5. IOCS Operating Commands
6. The Foreman
7. Service Systems
8. Loader and Allocator - Load

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SPACE TECHNOLOGY CERTIFICATE PROGRAM

AT COMPTON COLLEGE

COURSES LISTED UNDER EVENING ELECTRONICS

SPRING SCHEDULE 1968